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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Applicant(s) Joe Meyers

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Title: Roll Stability Control Using Four-Wheel Drive

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Lisa E. Brown

APPELLANTS' BRIEF ON APPEAL

Sir:

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I. Statement of Real Party in Interest

The inventor or inventors listed above have assigned their rights in the invention and the present application to Ford Global Technologies, LLC.

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II. Related Appeals and Interferences

There are no other appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

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III. Status of Claims

Claims 1-35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,479,348 to Sasaki in view of U.S. Patent No. 6,694,225 To Aga et al., hereinafter Aga.

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IV. Status of Amendments

An Amendment filed June 10, 2008 was entered by the Examiner. A response to a Final Office Action with no amendments to the claims was filed December 12, 2008.

V. Summary of Claimed Subject Matter

Claims 1-35 are pending in the application. Claims 1, 7, 16, 20, 24, 26 and 29 are independent. Claims 2 through 6 depend, either directly or indirectly from independent Claim 1. Claims 17-19 depend either directly or indirectly to independent Claim 16. Claims 21-23 depend either directly or indirectly from independent Claim 20. Claim 24 depends from independent Claim 23. Claims 27 and 28 depend from independent Claim 26. Claims 30-35 depend from independent Claim 29.

The present invention teaches and claims a method of controlling a vehicle with a 4X4 driving system and requires transferring driving torque both through an electronically-controlled center differential or an electronically controlled transfer case to the front wheel of the vehicle in response to a potential rollover condition signal so as to prevent rollover of the vehicle. The present invention is directed to integrating roll stability control and controlled differentials to enhance the performance as the systems are known to be operated separately.

The independent claims are presented as follows with reference to the figures, element numbers and paragraphs in the specification as filed:

1. A method of controlling a vehicle {Fig. 1, element 10, ¶ 0030} with a 4x4 driving system, said method comprising the steps of:

 determining a potential rollover condition from dynamic conditions sensed onboard said vehicle {Fig. 9, element 302, ¶0073}; and

 transferring driving torque {Fig. 9, elements 310, 312, 318, 324, and 328, ¶0073-0075} both through an electronically-controlled center differential or an electronically-controlled transfer case {Fig. 4, element 112, ¶0060} and to the front wheels {Fig. 1, elements 12a and 12b, ¶ 0030} of said vehicle so as to prevent rollover of said vehicle.

7. (Previously Presented) A method of controlling a vehicle {Fig. 1, element 10, ¶ 0030} with a 4x4 driving system, said method comprising the steps of:

generating a rollover signal in response to a potential rollover situation as determined from dynamic conditions sensed onboard said vehicle {Fig. 9, element 302, ¶0073};

increasing a torque in front outside wheel of said vehicle {Fig. 9, element 320 ¶0077} through a differential in response to said rollover signal {Fig. 9, element , ¶0077}; and

braking a rear outside wheel of said vehicle {Fig. 9, element 320, ¶0075} in response to said rollover signal.

16. (Previously Presented) A method controlling a vehicle {Fig. 1, element 10, ¶ 0030} having an active differential {Fig. 5, element 140 and 142, ¶0063}, said method comprising the steps of:

determining a rollover condition from dynamic conditions sensed onboard said vehicle {Fig. 9, element 302, ¶0073};

in response to said rollover condition, controllingly disengaging an inside wheel of said vehicle from an outside wheel of said vehicle with said active differential {Fig. 9, element 340, ¶0076}; and

thereafter, determining a wheel lift condition of said inside wheel {Fig. 9, element 346, ¶0076}.

20. (Previously Presented) A method of controlling a vehicle {Fig. 1, element 10, ¶ 0030} having a first wheel, a second wheel, and an active differential {Fig. 5, element 140 and 142, ¶0063}, said method comprising the steps of:

during a potential rollover event or stability control event, determining a slip condition of said first wheel of said vehicle {Fig. 9, element 300, ¶0073};

controllingly reducing torque to said first wheel in response to said slip condition using said active differential {Fig. 9, element 344, ¶0076}; and

controllingly increasing torque to said second wheel in response to said slip condition using said active differential {Fig. 9, element 348, ¶0076}.

24. (Previously Presented) A method of controlling a vehicle {Fig. 1, element 10, ¶ 0030} having an active differential {Fig. 5, element 140 and 142, ¶ 0063}, said method comprising the steps of:

determining a rollover condition from dynamic conditions sensed onboard said vehicle {Fig. 9, element 302, ¶0073};

in response to said rollover condition, controllingly disengaging a front outside wheel from an inside wheel of said vehicle with said active differential {Fig. 9, element 340, ¶0076};

applying a braking torque to said front outside wheel {Fig. 9, element 350, ¶0076}; and

applying a powertrain torque to a rear outside wheel of said vehicle so as to counter a deceleration caused by the braking of said front outside wheel {Fig. 9, element 350, ¶0076}.

26. (Previously Presented) A method of controlling a vehicle{Fig. 1, element 10, ¶ 0030} having an active differential {Fig. 5, element 140 and 142, ¶0063}, said method comprising the steps of:

determining a possible rollover condition from dynamic conditions sensed onboard said vehicle ; {Fig. 9, element 302, ¶0073} and

in response to said possible rollover condition, using said active differential to distribute torque between a front wheel, a front left wheel, a rear left

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wheel, and a rear right wheel of said vehicle so as to help prevent actual rollover {Fig. 9, elements 340, 344, 346, 348, 350, ¶0076}.

29. (Previously Presented) A roll stability control system {Fig. 8, element 26, ¶ 0069} for a vehicle {Fig. 1, element 10, ¶ 0030} having front wheels and rear wheels, said roll stability control system comprising:

a differential {Fig. 8, elements 112, 114, 116, ¶};

a rollover sensor operable to generate a rollover signal {Fig. 9, element 302, ¶0073}; and

a controller {Fig. 8, element 199, ¶0069} coupled to said rollover sensor and said differential;

wherein said controller is operable to control said differential so as to limit vehicle powertrain torque applied to said front wheels and thereby prevent rollover of said vehicle {Fig. 8, elements 202, 204 and 206, ¶0070}.

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VI. Grounds of Rejection to be Reviewed on Appeal

Are Claims 1-35 patentable under 35 U.S.C. §103(a) over Sasaki (USP 5,479,348) in view of Aga (USP 6,694,225)?

VII. Argument**Rejection of Claims 1-35 under 35 U.S.C. §103(a)**

Independent Claims 1, and 7 and 29 are directed to a system and method of controlling a vehicle having a 4X4 system and Independent Claims 16, 20, 24 and 26 are directed to a system and method of controlling a vehicle having an active differential. In each of the Independent Claims driving torque is transferred through an electronically controlled center differential or an electronically controlled transfer case to the wheels of the vehicle in response to a rollover signal or a potential rollover signal so as to prevent the rollover of the vehicle. The present invention integrates roll stability control and controlled differentials to enhance the performance of each system in comparison to the systems being separately operated.

The present invention is directed to a system and method that uses controlled driving torques through controlling the axle and center differentials to help reduce the potential for rollover or achieve roll stability control performance during a potential rollover. To accomplish this, the present invention teaches and claims transferring drive torque in both front and rear axles using a 4X4 system in response to a rollover signal. Therefore, roll stability control performances are achieved not only by the front outside wheel, but also by the rear outside wheel. Weight transfer due to acceleration through driving torque management in a 4X4

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system may be more favorable for roll stability control purposes than the weight transfer due to deceleration during braking from a brake control system. Acceleration causes the vehicle weight transfer from the front to the rear, while deceleration causes the vehicle weight transfer from the rear to the front. Both front and rear tires are effective in terms of removing lateral forces through increasing longitudinal forces. In teaching and claiming the steps of “determining a potential rollover condition” and “transferring driving torque..to the front wheels of the vehicle so as to prevent rollover”, the present invention integrates the driving torque control and the brake torque control. It should be noted that the effect of this may be to increase longitudinal slip through differential torque application to prevent rollover.

The Examiner asserted in the Office Action dated December 12, 2007 and in the Final Office Action dated October 14, 2008, that the Sasaki reference fails to teach or disclose “determining a potential rollover condition”. Applicants agreed, at page 9 first full paragraph, in the response filed December 12, 2008, and asserted that one skilled in the art would not look to combine Sasaki with a reference that teaches determining a rollover condition because the reference is directed to differential limiting torque control and not to roll stability control. Furthermore, Applicants argued at page 9, first full paragraph of the response filed December 12, 2008 that Sasaki teaches limiting differential action to keep longitudinal wheel slip below a threshold value which is fundamentally different

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than the method of control taught and claimed in the present invention. As stated above, in differential torque application taught and claimed in the present invention is dependent upon a rollover signal. In the teachings and claims of the present invention, the effect of the response to the rollover signal may be that dynamic vehicle conditions require transferring driving torque that may result in an increase in longitudinal slip. This goes against the teachings disclosed in Sasaki, which are directed to limiting slip differential to a predetermined threshold value, and would remain so regardless of a roll stability condition.

The Examiner asserted in the Final Office Action dated October 14, 2008, that it would have been obvious to one of ordinary skill in the art to modify Sasaki's teaching by generating a rollover condition to prevent rollover as evidenced by Aga. However, Applicants respectfully disagree.

The difference between rollover detection and rollover prevention should be noted. There is significant difference between rollover control pre-crash and rollover during a crash. These two distinct rollover situations will result in the vehicle and rollover control system operating under different circumstances and the vehicle control will be significantly different for each instance. The present invention is directed to detecting a potential rollover condition and initiating steps to prevent a rollover.

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It is respectfully asserted, and was presented in the response filed December 12, 2008, that neither the Sasaki nor the Aga references are directed to detecting a potential rollover condition, nor are the references directed to preventing a rollover event. The Sasaki reference is silent as to roll stability control. The Aga reference is directed to activating an occupant protection apparatus upon detection of a rollover condition and is not directed to detecting a potential rollover condition and preventing a rollover event. Therefore, as argued at page 9, last paragraph of the response filed December 12, 2008, there is no motivation or suggestion to combine the references as cited by the Examiner to integrate a roll stability control and a driving torque control system as claimed in the present invention.

Applicants have also presented the argument in the response filed December 12, 2008 that even if the references were to be combined as suggested by the Examiner, that their combination would not result in the Applicants' invention. Brake based roll stability control systems and electronically controlled differentials are typically both present on vehicles. However, the two systems operate independently of each other. Neither the Sasaki reference nor the Aga reference consider the synergy of the systems as taught and claimed in the present invention, and therefore, there is no motivation to combine the systems as suggested by the Examiner.

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Further evidence for this assertion may be supported by the fact that the Sasaki reference teaches limiting differential action to keep longitudinal wheel slip below a threshold (see Column 1, line 57 to Column 3, line 40). The present invention is directed to transferring drive torque, distributing drive torque and even, as claimed in claim 7, increasing drive torque in response to a rollover signal. Therefore, it is respectfully asserted that even if Sasaki were to be combined with a reference that provides a rollover signal, the teachings of Sasaki would still be to limit the differential action to keep the longitudinal wheel slip below a threshold and would not result in the present invention, which may result in an increase in longitudinal slip in response to the rollover signal in order to prevent rollover.

In a newly presented argument, Applicants respectfully assert that, in keeping with the description above relating to the teachings of Sasaki limiting differential action, the present invention is not a predictable result. It is respectfully asserted that the result and the success of the present invention, which does not limit the torque differential to a limit that keeps longitudinal wheel slip below a threshold, is not a solution that would be anticipated to succeed based on the known options. It is respectfully asserted that the result of the claimed combination would have been unexpected according to the teachings of Sasaki, even if combined with Aga. It is also respectfully asserted that this may be a reason why the innovation of the present invention has not been implemented before.

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Conclusion

The present invention teaches and claims integration between the driving torque control and the brake torque control to prevent rollover of a vehicle, which is neither taught nor disclosed in either reference cited by the Examiner. There is no motivation or suggestion to combine the references as suggested by the Examiner to integrate a roll stability control and a driving torque control system as claimed in the present invention. Therefore, it is respectfully asserted that one skilled in the art would not look to combine the references as cited by the Examiner and that even if the references were combined, their combination would not result in the Applicants' invention.

It is respectfully asserted that Claims 1-35 are patentable under 35 U.S.C. §103(a). Please charge Deposit Account 06-1510 the statutory fee for filing this document as required by 37 CFR 1.17(c).

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Respectfully submitted,

_____/Angela M. Brunetti/_____

Angela M. Brunetti
Registration No 41,647
Attorney for Applicant(s)

Date: 5/6/09

Angela M. Brunetti, PLLC
11300 E. Caribbean Lane
Scottsdale, AZ 85255
(480)200-2054
(480)513-9354 facsimile

VIII. Claims Appendix

1. (Previously Presented) A method of controlling a vehicle with a 4x4 driving system, said method comprising the steps of:

determining a potential rollover condition from dynamic conditions sensed onboard said vehicle; and

transferring driving torque both through an electronically-controlled center differential or an electronically-controlled transfer case and to the front wheels of said vehicle so as to prevent rollover of said vehicle.

2. (Previously Presented) A method as recited in claim 1, wherein the step of transferring said driving torque is performed when the speed of said vehicle is determined to be below a predetermined low speed threshold.

3. (Previously Presented) A method as recited in claim 1, wherein the step of transferring said driving torque is performed when a steering wheel angle of said vehicle is determined to be above a predetermined steering-wheel angle threshold.

4. (Previously Presented) A method as recited in claim 1, wherein the step of transferring said driving torque is performed when a throttle opening is determined to be below a predetermined throttle-opening threshold.

5. (Previously Presented) A method as recited in claim 1, wherein the step of transferring said driving torque is performed when both the speed of said vehicle is determined to be below a predetermined low-speed threshold and a throttle opening is determined to be below a predetermined throttle-opening threshold.

6. (Previously Presented) A method as recited in claim 1, wherein the step of determining said potential rollover condition is performed in response to a roll-rate signal.

7. (Previously Presented) A method of controlling a vehicle with a 4x4 driving system, said method comprising the steps of:

generating a rollover signal in response to a potential rollover situation as determined from dynamic conditions sensed onboard said vehicle;

increasing a torque in front outside wheel of said vehicle through a differential in response to said rollover signal; and

braking a rear outside wheel of said vehicle in response to said rollover signal.

8. (Previously Presented) A method as recited in claim 7, wherein the step of increasing said torque is performed when a throttle opening is determined to be above a predetermined throttle-opening threshold.

9. (Previously Presented) A method as recited in claim 7, wherein the step of increasing said torque is accomplished by increasing said torque to a full torque application level.

10. (Previously Presented) A method as recited in claim 7, wherein said method further comprises the step of reducing oversteer yawing in response to said increasing said torque in said front outside wheel and also said braking said rear outside wheel.

11. (Previously Presented) A method as recited in claim 7, wherein said method further comprises the step of braking a front inside wheel of said vehicle.

12. (Previously Presented) A method as recited in claim 11, wherein the steps of increasing said torque in said front outside wheel and braking both said rear outside wheel and said front inside wheel are performed when a throttle opening is determined to be above a predetermined throttle-opening threshold.

13. (Previously Presented) A method as recited in claim 7, wherein said method further comprises the steps of determining a wheel lift condition and braking a front inside wheel of said vehicle during the determination of said wheel lift condition.

14. (Previously Presented) A method as recited in claim 7, wherein the step of increasing said torque is performed using a limited-slip differential or a viscous coupling.

15. (Previously Presented) A method as recited in claim 7, wherein the step of increasing said torque is performed using a Torsen differential.

16. (Previously Presented) A method controlling a vehicle having an active differential, said method comprising the steps of:

 determining a rollover condition from dynamic conditions sensed onboard said vehicle;

 in response to said rollover condition, controllingly disengaging an inside wheel of said vehicle from an outside wheel of said vehicle with said active differential; and

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thereafter, determining a wheel lift condition of said inside wheel.

17. (Previously Presented) A method as recited in claim 16, wherein said method further comprises the step of applying engine torque to said outside wheel so as to prevent rollover of said vehicle.

18. (Previously Presented) A method as recited in claim 16, wherein the step of determining said wheel lift condition is accomplished by actively determining wheel lift.

19. (Previously Presented) A method as recited in claim 18, wherein actively determining said wheel lift is accomplished by applying a change in torque to said inside wheel and also monitoring a change in speed of said wheel.

20. (Previously Presented) A method of controlling a vehicle having a first wheel, a second wheel, and an active differential, said method comprising the steps of:

 during a potential rollover event or stability control event, determining a slip condition of said first wheel of said vehicle;

 controllingly reducing torque to said first wheel in response to said slip condition using said active differential; and

 controllingly increasing torque to said second wheel in response to said slip condition using said active differential.

21. (Previously Presented) A method as recited in claim 20, wherein said active differential is an active center differential.

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22. (Previously Presented) A method as recited in claim 20, wherein said active differential is an active axle differential.

23. (Previously Presented) A method as recited in claim 20, wherein determining said slip condition is accomplished in a traction control system (TCS).

24. (Previously Presented) A method of controlling a vehicle having an active differential, said method comprising the steps of:

 determining a rollover condition from dynamic conditions sensed onboard said vehicle;

 in response to said rollover condition, controllingly disengaging a front outside wheel from an inside wheel of said vehicle with said active differential;

 applying a braking torque to said front outside wheel; and

 applying a powertrain torque to a rear outside wheel of said vehicle so as to counter a deceleration caused by the braking of said front outside wheel.

25. (Previously Presented) A method as recited in claim 24, wherein the step of applying powertrain torque to said rear outside wheel is accomplished so as to balance a weight transfer from front to rear of said vehicle.

26. (Previously Presented) A method of controlling a vehicle having an active differential, said method comprising the steps of:

 determining a possible rollover condition from dynamic conditions sensed onboard said vehicle; and

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in response to said possible rollover condition, using said active differential to distribute torque between a front wheel, a front left wheel, a rear left wheel, and a rear right wheel of said vehicle so as to help prevent actual rollover.

27. (Previously Presented) A method as recited in claim 26, wherein distributing torque is at least partially accomplished by applying positive torque to a front outside wheel of said vehicle.

28. (Previously Presented) A method as recited in claim 26, wherein distributing torque is at least partially accomplished by applying positive torque to a front outside wheel of said vehicle so as to reduce understeer.

29. (Previously Presented) A roll stability control system for a vehicle having front wheels and rear wheels, said roll stability control system comprising:

a differential;

a rollover sensor operable to generate a rollover signal; and

a controller coupled to said rollover sensor and said differential;

wherein said controller is operable to control said differential so as to limit vehicle powertrain torque applied to said front wheels and thereby prevent rollover of said vehicle.

30. (Previously Presented) A roll stability control system for a vehicle as recited in claim 29, wherein said differential is an active differential.

31. (Previously Presented) A roll stability control system for a vehicle as recited in claim 29, wherein said differential is an active axle differential.

32. (Previously Presented) A roll stability control system for a vehicle as recited in claim 29, wherein said rollover sensor comprises a roll-rate sensor.

33. (Previously Presented) A roll stability control system for a vehicle as recited in claim 29, wherein said rollover sensor comprises a roll-rate sensor and a lateral-acceleration sensor.

34. (Previously Presented) A roll stability control system for a vehicle as recited in claim 29, wherein said rollover sensor comprises a roll-rate sensor, a lateral-acceleration sensor, and a vehicle-speed sensor.

35. (Previously Presented) A roll stability control system for a vehicle as recited in claim 29, wherein said rollover sensor comprises a roll-rate sensor, a lateral-acceleration sensor, a vehicle-speed sensor, and a yaw-rate sensor.

IX. Evidence Appendix

There is no Evidence Appendix herein.

X. Related Proceedings Appendix

There is no Related Proceedings Appendix herein.